The effect of group works and demonstrative experiments based on conceptual change approach: Photosynthesis and respiration

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Abstract

The purpose of this study is to investigate the effect of the use of group works and demonstration experiments based on conceptual change approach in the elimination of

misconception about the subject of photosynthesis and respiration in plants in pre-service science teachers. This study was conducted with 78 pre-service science teachers including 2 groups, the control and experimental, at the third grade student level of the Science Education Department at Gazi University in the Faculty of Education. The control group consists of 40 pre-service science teachers, and the experimental group consists of 38 pre-service science teachers. In addition, the study was conducted within the course of "Science Laboratory Application II" in 2007–2008 spring semester. Photosynthesis and respiration in plants concept test, developed by Kose (2004), was administered to pre-service teachers. The test was examined by scholars in the course field. The reliability co-efficient of the test was found as 0.78. According to the results, the academic achievement of students who take science and laboratory courses with an emphasis on the conceptual change approach was higher than the students who take the course using traditional approaches.

Keywords: demonstrative experiments, conceptual change approach, photosynthesis and respiration

Introduction

The main purpose of our education system is to master skills that could help students to reach to the information themselves, rather than transmitting existing information to them. Furthermore, apart from memorizing, the system should improve students' problem solving skills that they can use in a new scenario of the situation. Parallel to transmitting information to the students, the aim is to teach students about producing information and reaching the information that they will need. The expectation from current science education is a student-centered learning process with the guidance of a teacher. The teacher should be a guide that tries to understand the student's construction of knowledge, and in some cases facilitating learning process by asking some effective questions and additionally support them by guiding students to the right resources (Gedik et al., 2002). In this learning process, information that will be learnt should be arranged one by one to create a group of interrelated information. However, students will have some previous knowledge before coming into the education environment. This previous knowledge prevents the students from reaching scientifically proved information (realities), and as a result of this, it becomes hard or even impossible for the students to gain new information. In some research, researchers consider this situation and try to find ways to reach to the desired information in the teaching and learning process by using student's previous knowledge (Novak, 1984). New learning methods should be prepared and designed to integrate new information with his/her previous experiences based on discovery.

The Conceptual Change Approach, which is based on constructive learning theory, has frequently been used recently. It considers students' previous knowledge and then all instructional activities are determined with respect to those considerations. In many of instructional approaches, conceptual change does not occur at all or it occurs insufficiently. This situation leads to memorization and causes

misconceptions in certain subjects that need explanation, definition and estimation. For that reason, methods to overcome those misconceptions have very important role in science and technology education (Sönmez et al., 2001). One of the purposes of science and technology education is to have students learn concepts meaningfully and to use those concepts in their (daily) life (Yürük and Çakır, 2000). In order to achieve meaningful and permanent learning, misconceptions are supposed to be remediated. Misconceptions can be remediated by the revision of their previous knowledge and the modification of this previous knowledge to make it compatible with new information. This is called conceptual change process (Smith et al., 1993). This is an encouraging approach that achieves a transition from unscientific information or misconception that students' have to information that is accepted as scientific (Chambers and Andre, 1997). In other words, conceptual change is a change process of wrong previous knowledge to true and reliable information. The conceptual change approach includes several applications. Those applications include analogies and explanatory models, conceptual change texts, concept maps, hands-on activities, information processing skills, students' written answers, computer aided instruction, group work, demonstrative experiments and discussion.

Group work and demonstrative experiments have an important place in conceptual change approach. That is why group works and demonstrative experiments are better for students to feel out misconceptions about the subject and correct the misconceptions through questions and demonstrations (Gedik et al., 2002).

The first way to deal with student misconceptions is to be aware of them. Teachers must be aware of students' prior knowledge and possible misconceptions. During preparation of class topics and content, teaching methods that are suitable for reducing misconceptions should be chosen. In the method of demonstrative experiments based on conceptual change, students become aware of their existing misconceptions and these misconceptions are revealed through questions and demonstrations. These demonstrations and discussions enable students to realize scientific facts and combine them with their prior knowledge. Therefore, demonstrative experiments based on conceptual change are an effective method to reduce and prevent student misconceptions (Gedik et. al., 2002). Moreover, group work based on the conceptual change approach centralizes students and makes them the explorer and constructer of knowledge; this understanding is necessary to simplify the teaching of concepts. (Çaycı et. al., 2007).

One of the most accepted conceptual change theories is proposed by Posner et al. (1982). In order for the conceptual change to take place, Posner et al. (1982) suggested four conditions are necessary: (1) students must become dissatisfied with their existing conceptions (dissatisfaction); (2) the new concept must be clear and understandable for students (intelligibility); (3) the current problem should be

solved by using the new concept (plausibility); (4) similar future problems can be solved by using the new concept (fruitfulness).

The best way to understand a subject in science and technology education is to work on the subject and make connections with other science fields Turgut et al. (1997), therefore, science and technology education should accomplish integrity with other fields like physics, chemistry and biology. Especially for biology, connections and integrity of concepts have an important role in science and technology education. Therefore, biology is a more interrelated science field with respect to concepts that it covers compared to other science fields. Consequently, students have a few problems in learning concepts meaningfully, and they prefer to memorize those concepts. The most evident example of this can be seen in subject of photosynthesis and plants' respiration. Especially in studies that were performed on photosynthesis and plants' respiration, subjects reveal that misconceptions are very frequent (Haslam and Treagust, 1987; Tamir, 1989; Anderson et al., 1990; Amir and Tamir, 1994; Pedro, 1997; Çakıcı, 1998; Mikkilä-Erdmann, 2001; Yürük and Çakır, 2000; Alparslan, 2002; Tekkaya and Balcı, 2003; Çepni et al,. 2006; Köse et al., 2006; Köse and Uşak, 2006).

Tekkaya and Balcı (2003) carried out a study that aimed to determine the misconception of high school students on the concept of photosynthesis and respiration in plants. These researchers observed that most of the students had the idea that "photosynthesis is a gas alternation process, energy is produced after photosynthesis and photosynthesis is the reverse of respiration" which is scientifically invalid.

Çepni et al., (2006) carried out a study to reveal the cognitive development, misconceptions and attitudes of students about the photosynthesis concept. They concluded that, making use of the Computer-assisted Instruction Material (CAIM) was very crucial for attaining the application and comprehension levels of cognition in teaching photosynthesis. However, they observed that CAIM did not substantially change the misconception of students about photosynthesis.

For instance, the effect of conceptual change texts on students' misconceptions about respiration was investigated by Alparslan (2002). As a result of this study, it was concluded that conceptual change texts were more effective than traditional approaches in misconceptions of respiration.

Köse et al., (2006) investigated the effect of concept changing texts for reducing the misconceptions of pre-service teachers in the concept of photosynthesis and respiration in plants. At the end of the study, researchers observed that most of the pre-service teachers had misconceptions about photosynthesis and respiration in plants. They concluded that, concept-changing texts were efficient in the

comprehension of photosynthesis and respiration in plants and in the reducing misconceptions of pre-service teachers.

In another study, Köse and Uşak (2006) found that most of the pre-service teachers had some misconceptions in certain subjects like, "photosynthesis occurs only in green plants", "photosynthesis is a gas exchange process", "green plants respire only in nights when there is no light", "respiration occurs only in the leaf of plants". The main reasons for those misconceptions are: students' previous knowledge, the difference of scientific jargon and daily speeches and course textbooks.

In another study, Mikkilä-Erdmann (2001) investigated the effect of conceptual change texts on understanding of photosynthesis in 5th grade students. As a result of this study, researchers highlight that conceptual change texts have an important contribution to photosynthesis; especially on the students who have insufficient previous knowledge.

Research reveals that misconception is hard to eliminate through traditional approaches because it is a permanent and continuous process, and it is not sufficient to develop right concepts on students (Tekkaya et al., 2000). Therefore, there is a need to teach pre-service teachers with effective instructional approaches to overcome misconceptions that result in meaningful learning. In this study, the use of group work and demonstrative experiments based on the conceptual change approach is used and evaluated with respect to its effectiveness in photosynthesis and plant respiration.

Purpose

The purpose of this study is to investigate the effect of the use of group work and demonstrative experiments based on the conceptual change approach in the elimination of misconception about photosynthesis and respiration in plants on pre-service science teachers.

The Method of the Study

Subjects

This study is conducted with 78 pre-service science teacher including 2 groups, the control and experimental, at the third grade student level teachers of Science Education Department at Gazi University in the Faculty of Education. The control group consists of 40 pre-service science teachers including 21 women and 19 men, and the experimental group consist of 38 candidate teachers including 27 women and 11 men. In addition, the study was conducted within the course Science Laboratory Application during 2007–2008 Spring semester. Group work and

demonstrative experiments based on conceptual change approach were randomly applied on selected pre-service science teachers in the experimental group during course sessions about photosynthesis and respiration in plants. Randomly selected pre-service teachers in the control group handled the subject in traditional methods.

The Tool for Collecting Data

"Photosynthesis and respiration in plants concept test"

Photosynthesis and respiration in plants concept test which was developed by Kose (2004) was given to pre-service teachers. Questions in this test were constructed with translation of literature and the results of the questionnaire and interviews which were held by Kose (2004). The 20-item multiple choice test has two phases. In the first phase of the test, pre-service teachers' content knowledge was assessed. In the second phase, clarity of that knowledge that pre-service teachers had was assessed. Also, the validity of concept test was evaluated. The reliability of concept test was calculated as alpha=0.78.

In the first stage of the test there were multiple choice questions that contained common misconceptions determined by interviews and the written examination. In the second stage of the test, the underlying reasons of those decisions were discovered by asking questions like, "the reason why I chose this choice is that" with multiple choice answers. In multiple choice reasons there was a right answer as well as misconceptions that pre-service teachers have. In the grading process of the photosynthesis and respiration in plants concept test, the right choice-right reason is valued as 3 points, the wrong choice right reason is valued as 2 points, the right choice wrong reason is valued as 1 point, and the wrong choice-wrong reason is valued at 0 points.

Conceptual testing of photosynthesis and respiration consists of two stages. These two stage tests have been extensively used by many researchers for fifteen years in different fields of science (Haslam and Treagust, 1987; Odom and Barrow, 1995). Tests consisting of two stages are different from multiple choice tests because of the second stage component. The second stage of the test could be either an interview or a form containing student misconceptions derived from literature investigation based on the students' misconceptions. There are studies that two-stage tests provide important conveniences to determine misconceptions of students and their reasons (Haslam and Treagust, 1987; Odom and Barrow, 1995).

Research Design

This study was conducted on science education pre-service teachers while they are studying photosynthesis and respiration in plantsduring a science laboratory application course. The experimental group used group work and demonstrative

experiments based on the conceptual change approach. The control group took the traditional course. In the control group, researchers want pre-service teachers, who will teach the subject, not to prepare extra materials beforehand and to present the content using a traditional approach. While preparing group work and demonstrative experiments based on conceptual change approach, it was necessary that students' misconceptions on the related subject should be considered. Moreover, the minimization or elimination of those misconceptions was the goal. The students were expected to realise the subject and orient demonstrative experiments and group work. Pre-service teachers, who would instruct the subject in the experimental group, should prepare extra materials and demonstrative experiments, as well as presenting theoretical information about photosynthesis and respiration in plants.

In experimental group, pre-service teachers who would teach the photosynthesis and respiration in plants were prepared to experiment set-ups on questions like: *"Does sunlight affect the growth of plant?", "Do plants transpire?", "Do plants respire?", "Does air have any effect on plants?", "Does respiration continues on day and night?", "Does light have effect on photosynthesis?", "understanding fermentation", "understanding the factors that effect photosynthesis", "the structure of chloroplast, mitochondria and their differences"*. The pre-service teachers show and present the experiments that they prepared beforehand. The applications took 3 weeks at the beginning of the 2007–2008 Spring semester. The photosynthesis and respiration in plants concept test was conducted on both the experimental and control groups. Four weeks after the application of the pre-test, post tests were conducted to both the experimental and control groups.

Data Analysis

In this study, group works and demonstrative experiments based on the conceptual change approach were used in the experimental group. On the other hand, the control group used traditional approaches. In order to assess whether there was a significant difference among control and experimental group, and within those groups knowledge of photosynthesis and respiration in plants concept test, the t-test was used. An independent sample t-test was conducted to understand the difference among the dependent variable of experimental and control group and whether it is significant in 95%-99% confidence interval or not. The paired sample t-test was conducted in the experimental and control group to understand the difference before and after treatment.

Moreover, in order to achieve homogeneity of groups before treatment results of independent sample t-test for each group was compared in addition to an analysis and comparison of these mean scores, standard deviations, t values and p values.

Results

Homogeneity of groups before treatment

This study was conducted on two groups, the experimental and control groups. In order have homogeneity in each group, pre-test scores of the photosynthesis and respiration in plants concept test were considered. In order to see whether there is a difference among different variables of groups, an independent sample t-test was conducted. The values of the mean scores, standard deviation, t values are listed below in Table I and Table II.

Table I. *Control and experimental groups pre-test achievement scores on photosynthesis and respiration in plants concept test and independent t-test scores*

Group	N	$\overline{X}$	S	Sd	T	p (Significance)
Control	40	33.12	7.97	76	-0.929	0.356
Experimental	38	34.57	5.56			
* p<0.05						

When Table I was analyzed, no significant difference was found among pretest achievement scores of the control and experimental groups ($t(76) = -0.929$; $p > 0.05$). Achievement test scores of experimental group students before treatment ($\overline{X} = 34.57$) was higher than control group students' score ($\overline{X} = 33.12$), but this difference is not significant to the 95% confidence interval. This result shows that pre-service teachers' conceptions on photosynthesis and respiration in plants are approximately same before the application. We can conclude that both groups have the equal concept knowledge.

Is there a significant difference among achievement scores of experimental group students who used group work and demonstrative experiments based on conceptual change approach compared to control group students who used traditional instructional methods in teaching concepts of photosynthesis and respiration in plants?

The photosynthesis and respiration in plants concept test was conducted as a post-test in experimental and control group. The result of Independent sample t-test scores is presented in Table II.

Table II. *Control and experimental groups post-test achievement scores on Photosynthesis and respiration in plants concept test and independent t-test scores*

Group	N	$\overline{X}$	S	Sd	T	p (Significance)
Control	40	33.37	7.46	76	-3.301	0.001
Experimental	38	38.15	5.03			
* p<0.05						

As it is represented in Table II, there is a significant difference among the post-test achievement scores of control and experimental group ($t(76) = -3.301$; $p < 0.01$). Mean score of experimental group achievement ($\overline{X} = 38.15$) is much higher than control group's achievement ($\overline{X} = 33.37$) score. This result represents that treatment used on experimental group dramatically enhanced students' achievement. This result shows that, group work and demonstrative experiments based on the conceptual change approach reduce the misconceptions of pre-service teachers on the concept of photosynthesis and respiration in plants.

Is there a significant difference among experimental group students' pre and post-test achievement scores?

Table III. *Experimental group students' t-test results with respect to pre and post-test students' achievement scores*

Test	N	$\overline{X}$	S	Sd	T	p (Significance)
Pre test	38	34.57	5.56	37	-2.806	0.008
Post test	38	38.15	5.03			
* p<0.05						

Table III indicates that there is a significant difference among pre test and post-test scores in the experimental group's achievement test ($t(37) = -2.806$; $p < 0.01$). The mean score of students' pre-test score is $\overline{X}$=34.57, and the post-test score is

$\overline{X}$=38.15. This result shows that the treatment used on the experimental group dramatically enhanced students' achievement. According to this data, it can be concluded that the applied method positively affected the conceptual success of pre-service teachers on photosynthesis and respiration in plants. Researches revealed that making use of different teaching strategies in classrooms positively affected the pre-service teachers' learning of concepts (Haslam and Treagust, 1987; Alparslan, 2002; Köse et al., 2006).

Is there a significant difference among control group students' pre and post test achievement score?

Table IV. *Control group students' t-test results with respect to pre and post-test students' achievement score*

Test	N	$\overline{X}$	S	Sd	t	p (Significance)
Pre test	40	33.12	7.97	39	-0.126	0.900
Post test	40	33.37	7.46			
* p<0.05						

Table IV shows that there is no significant difference among pre test and post-test scores of students' achievement test in the control group ($t(39) = -0.126$; $p < 0.01$). The mean score of students' pre-test in the achievement test is $\overline{X} = 33.12$, and the post-test score is $\overline{X} = 33.37$. This result reveals that traditional approaches used on the control group did not enhance students' achievement.

Discussion

Teachers have a very important role in realization of the correct education concepts. The educational approaches of today make emphasis the student instead of teacher. The student centered educational approach requires students to be more active in the classroom and participate at all levels (Demirel, 2005).

In traditional teaching methods, teacher-centered approaches dominate the teaching process. The teacher gives information to students, and the students' duty is to learn information that is given by teacher. On the other hand, in student-centered approaches, the role of the teacher and students should be compatible with the contemporary learning theories. In the contemporary learning process, the student constructs new information while examining previous knowledge in order to

determine what is known; during this process the student constructs his/her learning with experimentation, application, research and observation order (Orhan, 2004).

Consequently, it is important for pre-service teachers and in-service teachers to be informed contemporary learning methods and techniques (group work and demonstrative experiments) in order to investigate how these methods make learning easier and to obtain skills in how to apply these methods (Ekici, 1996; Saka and Akdeniz, 2001). In science education, the application of these methods and techniques are very broad. The fundamental purpose of science education is to provide ways for students to learn concepts meaningfully. One of the obstacles behind meaningful and permanent learning is misconceptions. When recent studies of science education were analyzed, the results show that in many subjects of science education students have misconceptions (Pfundt and Duit, 2000; Taber, 2002). One of the reasons for these misconceptions is teachers existing misconceptions about the subject (Yip, 1998; Sanders, 1993). For that reason, the determination of in-service and pre-service teachers' misconceptions and educating them with correct information is supposed to be guaranteed (Köse, 2004). In addition to the misconceptions, it is important to find approaches to eliminate these misconceptions (Özmen and Demircioğlu, 2003). One of the approaches developed for this purpose is the conceptual change approach.

In this study, group work and demonstrative experiments based on the conceptual change approach were used in science education pre-service teachers to investigate the elimination of misconceptions in photosynthesis and respiration in plants and compared to traditional approaches.

When the results of this study were analyzed, the experimental group and control group's pre-test academic achievement scores were close to each other, and there was no significant difference between them ($p < 0.01$). On the other hand, academic achievement post-test results of experimental and control group reveal that there is a significant difference. Therefore, the academic achievement of the experimental group students who took the course with the conceptual change approach achieved higher post-test results than control group students who took the course with the traditional approach. Group work and demonstrative experiments based on the conceptual change approach seem to be very effective in eliminating the experimental groups' misconceptions in photosynthesis and respiration in plants in the science laboratory application course. The underlying reason is that the strategies applied in the conceptual change approach explain misconceptions between scientific information and existing information. These misconceptions are highlighted exactly and clearly. Moreover, in this approach, those concepts were presented to make them more concrete. This study reveals compatible results with previous studies like Sungur (2000), Mikkilä-Erdmann (2001), Köse et al., (2006), Köse and Uşak (2006), Başer and Geban, (2007). Waheed and Lucas (1992) and

Johnstone and Mahmoud (1980) found that photosynthesis and respiration in plants are the most confusing subjects fot the students.

The research of Griffard and Wandersee (2001) and Seymour and Longden (1991) reveal that pre-service teachers have misconceptions of the difference of plant and animal respiration. They even have wrong information, like plants do not respire. This misconception is due to the wrong information that they have. They are educated mostly on animal and human respiration. As a consequence of our study, group work and demonstrative experiments based on the conceptual change approach is more effective than traditional approaches in the elimination of misconceptions in photosynthesis and respiration in plants topic in science education pre-service teachers.

Köse et al., (2006) concluded that conceptual change texts based on the conceptual change approach reveals more satisfactory results than traditional approaches on the topic of photosynthesis and respiration in plants. The results of this study are consistent with the study of Köse et al., (2006) in that applications based on conceptual change are more effective than the traditional educational approaches.

In the study that was conducted by Gedik et al., (2002) students used the demonstration method, based on the conceptual change approach, hinted at possible misconceptions and those misconceptions was detected with questions and demonstrations. Demonstrations and discussions make it possible for students to notice scientific facts and to connect them to their previous knowledge. Students discover scientific facts while observing and discussing. Therefore, it was determined that the demonstration method, which is based on the conceptual change approach, causes decreases in the misconceptions of students and prevents them altogether. The results of our study are also consistent with the study of Gedik et al., (2002) in that demonstrative experiments based on the conceptual change approach are used, and the group in which the demonstration is applied is more successful and their misconceptions are reduced.

Hynd et al., (1994) in their studies of ninth and tenth class primary school students divided the class into groups of eight students. First, previous knowledge about the subject was found. Then, they applied demonstration and discussion strategy based on the conceptual change approach to student groups. Researchers evaluated a test to find out the conceptual change of participant students either before or after the application. It was observed that intuitive ideas based on prior information about the subjects had been transformed into scientific information. Our studies resemble this because demonstrations based on conceptual change were used, prior knowledge of students were measured before the application and the success of the students increased after the application.

Stavy et al., (1987) conducted a questionnaire to find out basic misconceptions about photosynthesis and respiration among eighth and ninth pimary students. This questionnaire contained open-end questions. They determined that the students had some misconceptions about the subjects. Strategies based on the conceptual change approach applied to the student group and the misconceptions were corrected. The results of this study are also consistent with the study of Stavy et al.(1987) ; making use of the group work and demonstrative experiments based on the conceptual change approach fixed the misconceptions of pre-service teachers on the concept of photosynthesis and respiration in plants.

Yenilmez and Tekkaya (2006) investigated the effect of conceptual change text and internet media to better understand the subject of photosynthesis and respiration for students. In their studies (2006), they observed that experimental group, using the conceptual change approach, was more successful than the control group in understanding photosynthesis and respiration concepts. It was also observed that the academic success of students in the experimental group on the concept of photosynthesis and respiration in plants was higher than the control group with whom the traditional educational approach was used.

The result of this study represents that traditional approaches seem to be ineffective in the elimination of misconception in pre-service and in-service teachers. Therefore, alternative learning methods need to be used to overcome misconceptions.

Implications for Education

In this study, when the results were considered, strategies applied in conceptual change approach found that using group work and demonstrative experiments is much more effective than applications based on traditional teaching methods. Therefore, this application of the conceptual change approach will make an important contribution to the elimination of misconceptions on pre-service teachers in other topics of the science and laboratory applications course.

This investigation may be conducted with wide ranging group.

Applications based on the conceptual change approach, using group work and demonstration experiments, are very effective in elimination of misconceptions. Further investigation can determine whether this approach is also effective on laboratory applications of other courses like physics, chemistry and biology.

In this study, it was observed that a multiple choice conceptual test consisting of two stages is very effective in determining misconceptions of pre-service teachers. With the help of the test, pre-service teachers can discover the underlying reasons

in their mind. This type of test can also be prepared for other topics in the Applications of Science Laboratory course.

An instruction method is supposed to eliminate the misconceptions and increase the achievement of students. A comparative study can be made with other teaching methods, such as multiple intelligence, problem solving, cooperative teaching and analogies to determine the efficiency of the methods of group work and demonstrative experiments.

To correct the misconception of pre-service teachers, analogies and explanatory models based on the conceptual change approach, using conceptual change texts, conceptual maps, concrete activities, data processing skills, written texts of students and computer-assisted education activities based on discussion strategies can be used as well as group work and demonstrative experiments.

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Appendix

A. SAMPLE QUESTIONS OF PHOTOSYNTHESIS AND RESPIRATION IN PLANTS SUBJECTS BASED CONCEPTUAL CHANGE APPROACH

1. Which of the following choices about the respiration in plants and animals is true?

I. Respiration in plants is photosynthesis.

II. Plants make respiration only nights, animals makes all the time.

III. There is no difference between respiration in plants and animals, both are similar.

IV. Plants make anaerobic(without oxygen) respiration, animals make aerobic(with oxygen) respiration.

V. While respiration in plants occurs in leaf cells, in animals, it occurs in lung cells.

The reason why I chose this/these choice/choices is that,.....:

While the plants take carbon dioxide and give out oxygen during day, they take oxygen and give out carbon dioxide at nights.

Plants do not make respiration during the photosynthesis.

Products derived from respiration can be already provided by photosynthesis because plants have different organelles and enzymes.

Respiration in plants and animals occur in a same way.

Plants have special organelles for respiration

. .....

2. 20 small circular pieces, whose diameter is 1 mm, was cut from the leaves which have similar properties from a geranium plant in three different times. Firstly it was cut at 04:00 am (group A), secondly it was cut at 04:00 pm in the same day (Group B), and last one was at 04:00 am in the next day (Group C). Then, the pieces are dried (dehydrate) at 105 ^{o}C and weighted. Which of the following results can be obtained?

I. Group C has the most dried weight.

II. Group B has the most dried weight.

III. Group A has the most dried weight.

IV. Group B has minimum dried weight.

The reason why I chose this choice is that,.....:

The use of water as a raw material during the photosynthesis process increases the dried weight.

Dried weight is minimum in the morning because plants make respiration only at nights, so organic compounds are broken into pieces at nights.

Dried weight of leaf increases at 04:00 pm afternoon because the weather is very hot; consequently, the more amount of water is lost by transpiration.

It is an increase in the Amount of product by continuation of photosynthesis of the leaf along the day. A major amount of product is transported to other organs of plants at night.

.....

3. Which of the following choices is the general equation of photosynthesis?

I. CO_2 + energy $\longrightarrow$ Glucose + H_2O

II. Glucose + O_2 $\longrightarrow$ CO_2 + H_2O + energy

III. $6CO_2 + 6H_2O \rightleftharpoons C_6H_{12}O_6 + 6O_2$

IV. $6CO_2$ + +H_2O $\longrightarrow$ nutrient + O_2

V. Carbon dioxide + water $\longrightarrow$ Glucose + energy

The reason why I chose this/these choice/choices is that, ...:

Chlorophyll pigment produce glucose and water by binding light energy and carbon dioxide.

With the help of light energy, nutrient and energy is produced from carbon dioxide and water.

Sun light produce glucose and oxygen by combining carbon dioxide and water with the help of chlorophyll in plants.

Carbon dioxide, water and energy emerge by combining glucose and oxygen with the help of sunlight. Glucose and oxygen are produced by combining carbon dioxide and water. Reverse case can be also realized in appropriate conditions.

.....

4. Which of the following items comparing the processes of respiration and photosynthesis in plants is true?

Photosynthesis	**Respiration**
Occurs only in green plants.	Occurs only in animals.
Occurs in all the plants.	Occurs only in all animals.
Occur in green plants if light energy is available.	Occurs in all plants and animals at all times.
Occur in green plants if light energy is available.	Occur in all animals always, occur in all plants unless light energy is available.

The reason why I chose this/these choice/choices is that,.....:

Green plants do not make any respiration during photosynthesis while green plants make photosynthesis during the day, they respire at nights,.

Green plants respire under the condition when they can not gain enough energy from photosynthesis; animals make respiration because they can not make photosynthesis.

Photosynthesis occurs in green plants under the condition that the light energy is available; on the other hand respiration occurs in all living organisms at all times.

.....

5. Which of the following factors during the photosynthesis process is not important?

I. Amount of Oxygen.

II. Amount of chlorophyll.

III. Amount of water.

IV. Amount of carbon dioxide

V. Amount of light

The reason why I chose this/these choice/choices is that,.....:

Photosynthesis may also occur under the condition that the light is not available.

Photosynthesis may also occur under the condition carbon dioxide is not available.

Mushroom-like-plants which are not green and not containing chlorophyll pigments may also make photosynthesis.

There is no need to oxygen for photosynthesis.

Photosynthesis may also occur without using water.

B. SAMPLE MODELS AND MAPS OF PHOTOSYNTHESIS AND RESPIRATION IN PLANTS

Figure 1: Structure of Chloroplast

Figure 2: Does Continue Respiration Day and Night?

Figure 3: Structures of Chloroplast and Mitochondria

Figure 4: Living Beings in the Food Chain and Conception Map Which Shows Living Beings' Relationship between Their Respiration

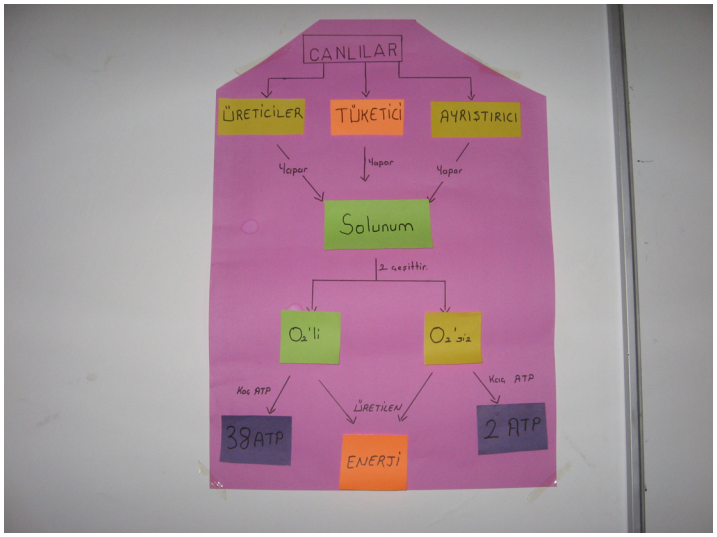

Figure 5: Table of Meaning Analysis Relationship between Photosynthesis and Respiration in Plants